Space Weather Technical Forecast

Issued on Thursday 20 March 2025 at 01:01 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout. Chance G1-G2/Minor-Moderate Storms Days 1-3 (20-22 Mar) due to CME arrivals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M1.5 flare observed at 19/2040 UTC from AR4031 in the northwest quadrant. There are currently eleven sunspot regions on the visible disc. AR4028 and AR4031 are the two largest and slightly more magnetically complex regions on the disc. Both continue to see some growth of trailer and intermediate spots. AR4035 continues to rotate onto the disc in the northeast, currently appearing to be a simple beta group. AR4034 has seen some slightly larger trailer spots develop. None of the remaining spots are showing any significant magnetic complexity, and are relatively small or appear to be stable.

A filament eruption from the north-centre disc was observed around 19/0036 UTC, which produced a narrow CME observed in coronagraphy imagery. This has been analysed and the results show a potential glancing blow on Day 3 (22 Mar).

No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, were at slightly elevated levels, ranging between 440 to 520km/s, possibly due to a weak transient feature or lingering HSS from CH23/-. Density was below average. Interplanetary Magnetic Field, Bt, was weak to moderate, peaking at +12nT, with the north-south component, Bz, weak to moderate, ranging between +6 and -11nT, favouring a negative orientation. Phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp2-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was mostly at background to moderate. The 24-hour fluence was below the Active threshold. The observed integrated pfu was 1.44e7 at 20/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with an ongoing chance of isolated M-class flares.

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Solar Wind / Geomagnetic Activity: There are four CMEs which feature in the forecast in the coming days (20-22 Mar). Solar winds are likely to remain mostly at slow to slightly elevated levels, with elevated enhancements possible due to forecast CME arrivals. Quiet to Active activity expected initially, with a chance of G1-G2/Minor-Moderate storms Days 1-3 (20-22 Mar) should any of the four possible CMEs arrive and/or combine. A further enhancement is possible on Day 4 (23 Mar) due to a high speed stream from CH24/-, which is currently near the centre-disc.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement from any larger flares. High energy electron flux is expected to continue at background to moderate levels. Electron (1e8 integrated pfu) fluence should remain below the Active threshold throughout the period.

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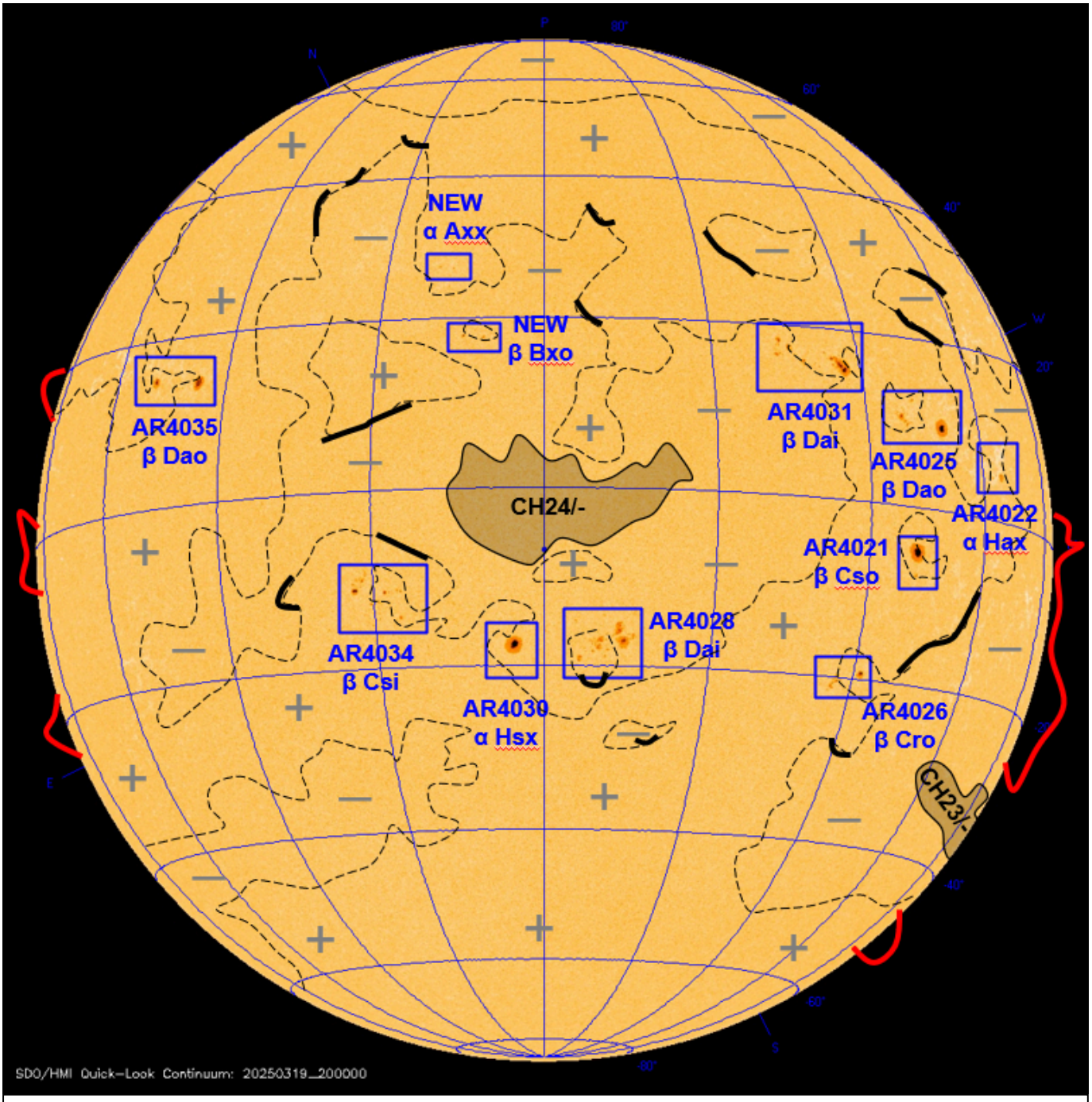
Figure 1: Solar Synoptic Map valid 19/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are four CMEs which feature in the forecast.

The first from a filament eruption which occurred in the northeast quadrant, within the vicinity of CH24/-, at 16/2020 UTC. This produced a partial halo CME in coronagraph imagery, with an associated shock evident. Analysis suggests a possible glancing blow arriving at Earth early on Day 1 (20 Mar). Given the filament was near CH24/-, there may have been some deflection towards the south and west, which has been taken into consideration. EPAM observations showed a rise in low energy protons around 19/0900 UTC, possibly signalling a slightly earlier arrival than originally forecast, although no evidence to suggest a CME has arrived in the solar wind data.

The second CME was from a filament eruption in the northwest around 17/1030 UTC, just ahead of AR4025 with ejecta clearly leaving to the west, though a faint halo can be seen later on Stereo-A imagery. This CME forecast for late Day 1 (20 Mar).

The third CME was associated with the 17/1930UTC M1.0 flare and filament eruption from a region of plage in the northeast. This CME mostly travelled north, but once again may have an Earth-directed component, perhaps arriving early on Day 2 (21 Mar). Confidence in the geomagnetic forecast is low due to the number of possible CMEs, and the possibility one or more possibly combining in transit, or even miss Earth all together.

The fourth is a CME which was observed to the NE, possibly as a result of a filament eruption from the north-centre disc that occurred around 19/0034 UTC. This has been analysed and results in ENLIL suggest a potential glancing blow at Earth on Day 3 (22 Mar).

Further enhancement is likely from CH24/- which is currently near centre disc. This is likely to move in geoeffective location in the western hemisphere in a few days time, with a possible high speed stream arriving at Earth either on Day 3 or 4 (22-23 Mar), with solar winds reaching up to 450-500km/s.

Geomagnetic activity is expected to be Quiet to Active initially, with a chance of G1-G2/Minor-Moderate storms Days 1-3 (20-22 Mar) should any of the above CMEs arrive and/or combine, possibly continuing into Day 4 (23 Mar) due to possible CH/HSS connection.

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Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	30	40	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
17/0253	Partial	Filament Eruption	Northeast	580	19/2100	A large shock associated with this CME.
17/1809	Partial	Filament Eruption	Northwest	600	20/1800	Low confidence on exact timing due to interactions with other CMEs. May combine.
18/0215	Partial	Filament Eruption	Northeast	520	21/0100	Low confidence. Chance of a glance.

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Figure 2: MOSWOC ENLIL shows potential CME arrivals in the coming days (20-22 Mar).

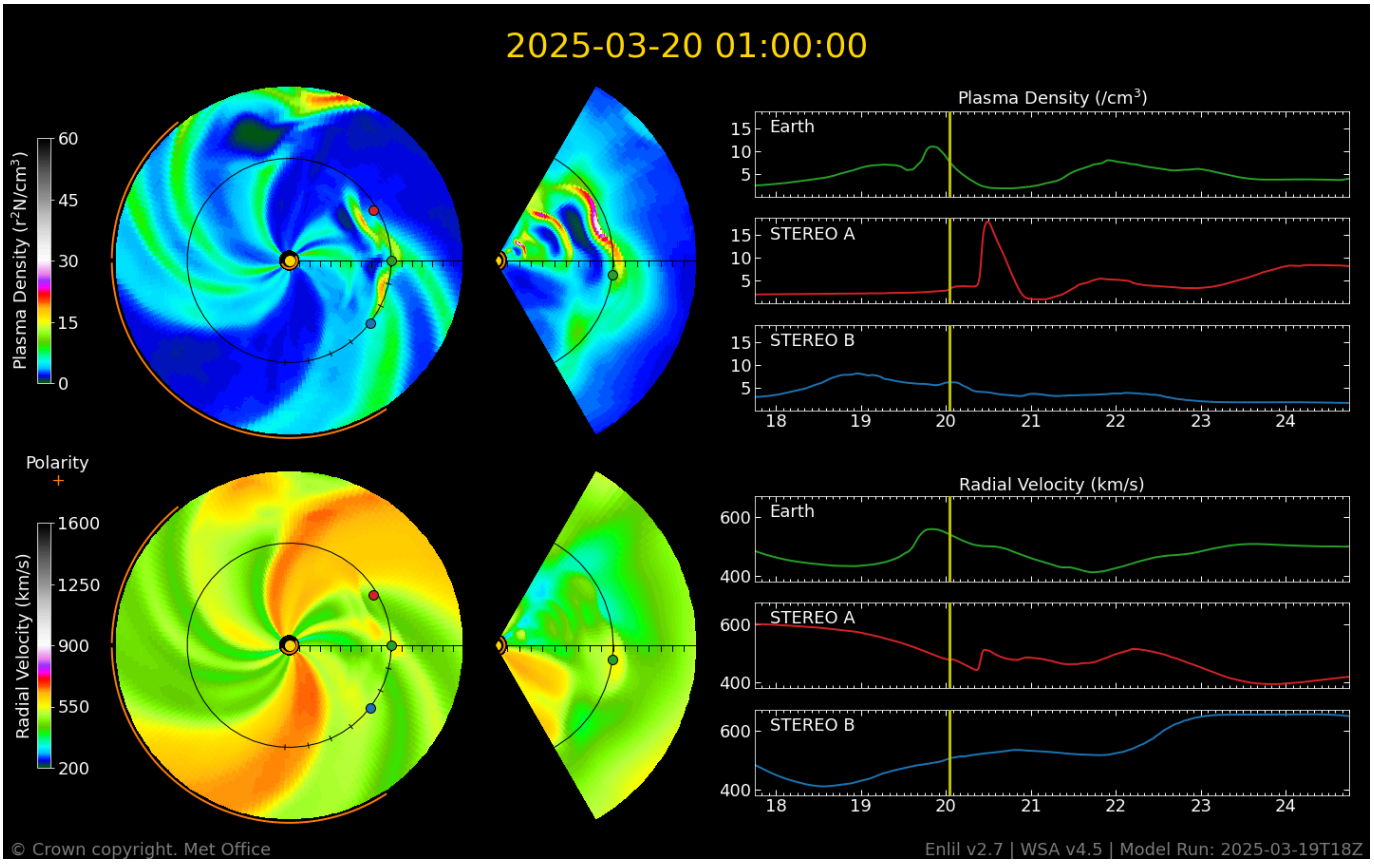

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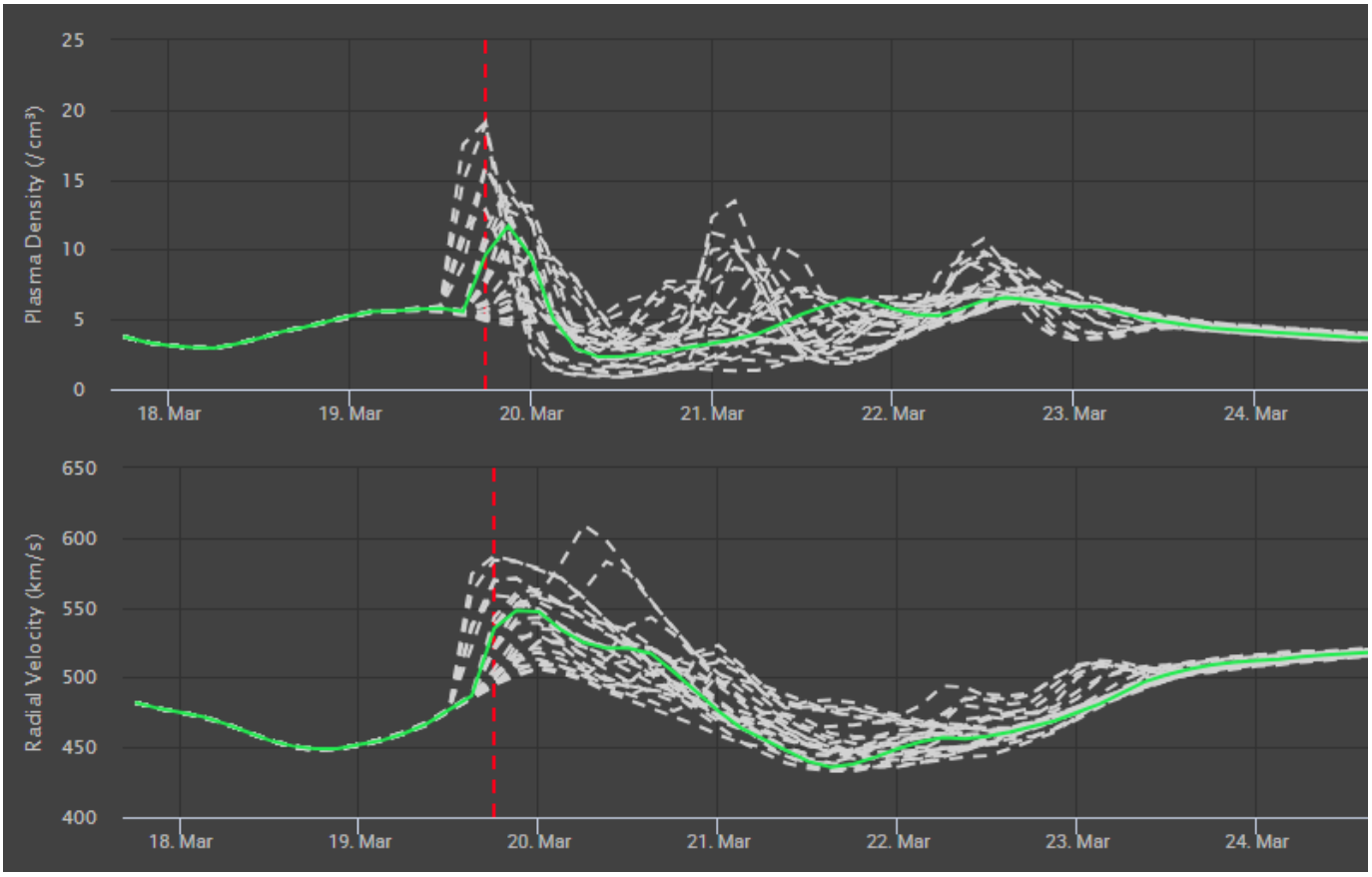
Figure 3: MOSWOC Enlil Ensembles - shows potential timings, density and speeds of potential CME arrivals in the coming days (20-22 Mar).



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Radio Blackouts - X-Ray Flares

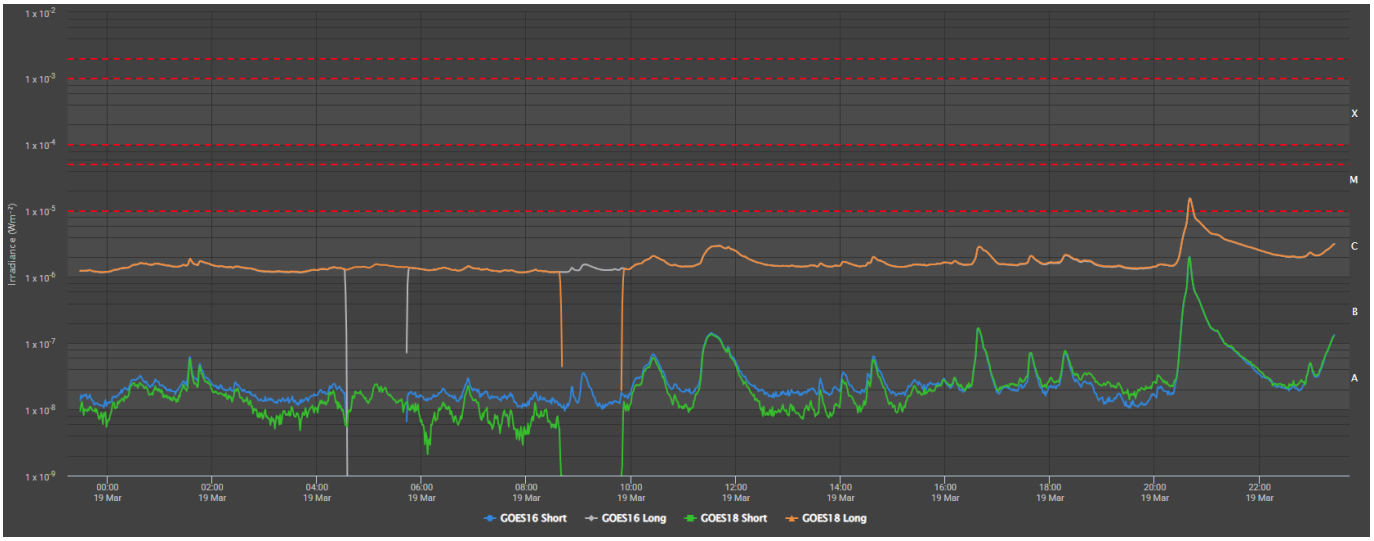
Solar activity has been Moderate, with an M1.5 flare observed at 19/2040 UTC from AR4031 in the northwest quadrant.

There are currently eleven sunspot regions on the visible disc. AR4028 and AR4031 are the two largest and slightly more magnetically complex regions on the disc. Both continue to see some growth of trailer and intermediate spots. AR4035 continues to rotate onto the disc in the northeast, currently appearing to be a simple beta group. AR4034 has seen some slightly larger trailer spots develop. None of the remaining spots are showing any significant magnetic complexity, and are relatively small or appear to be stable.

Low to Moderate activity is expected, with a chance of further isolated M-class flares.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	40	40	40	40
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 4: GOES16-18 X-Ray Flux trace.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current inactivity and magnetic simplicity of the small regions on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

GOES16 High energy (>2MeV) Electron flux has fallen from diurnally high levels over recent days down close to background. With possible CME arrivals expected over the next few days (20-22 Mar), this may serve to clear some electrons from their orbits, keeping flux at background to moderate levels, although prior to, or in the absence of, any CME arrivals electron flux could return to high levels. Confidence is therefore low due to these uncertainties in the CME forecast.

MOSWOC REFM shows the electron fluence should remain below the Active threshold throughout the remainder of the period, especially with possible CMEs arrivals in the coming days, and is considered reasonable guidance, albeit with low confidence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: GOES16 Electron Flux

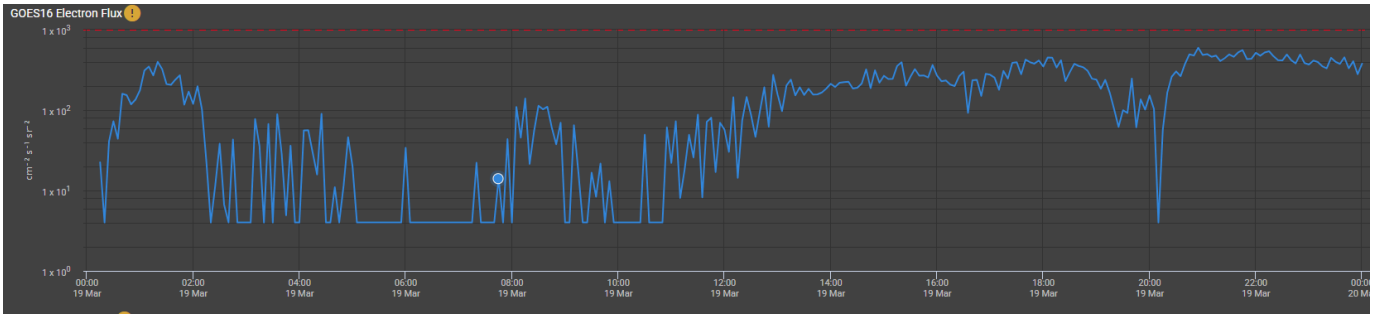

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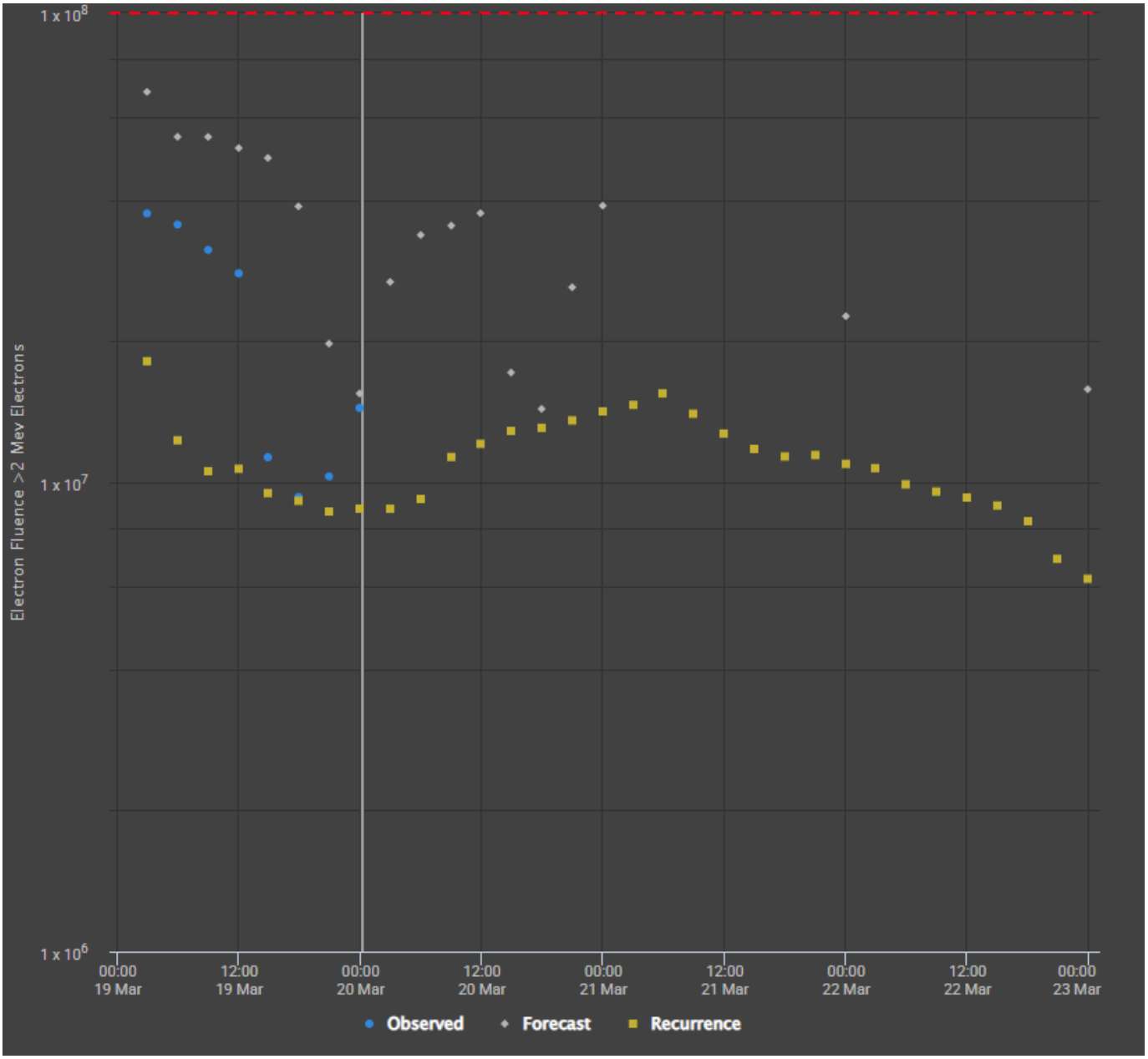
Figure 6: MOSWOC REFM electron fluence.



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